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NCAA Sports Value Modeling: Assessing Alignment with USMA's Mission

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Abstract: The United States Military Academy (USMA) is currently without a scalable model that enables decision makers to assess value as it pertains to National Collegiate Athletic Association (NCAA) sport teams at the Academy. This research aims to establish this aid, which establishes a numerical value score to each NCAA sport team at West Point. The model will align the school's culture to reflect the value as seen by stakeholders of USMA as a school and as a military institution. The results attained from this model will define a snapshot of what value is attributed to each NCAA sport team. Further utilization of these numerical value scores will be utilized to identify strengths and weaknesses within teams at USMA.

Keywords: United States Military Academy, National Collegiate Athletic Association, Value Modeling

1. Introduction

1.1 Background

The NCAA sporting landscape has drastically evolved over the past decades with the inclusion of legislation, such as Convention Proposal No. 48, Title IX, and more recently Name-Image-and-Likeness (NIL) deals. These rulings have molded schools on how one defines an athlete and how one defines value as it pertains to sport teams. The complexities have muddled the NCAA recruitment and admission process into the "wild west" as it is a chaotic, revolutionary environment (Magnusen, 2021). Many schools with the ability to attract recruits using promotions and benefits stand to benefit. This situation raises a problematic question: how does one allocate funds across a school's teams? This is the base predicament, as it forces schools to critically evaluate the cost-benefit of their NCAA sport teams. This question can be better solved by reframing the problem into simpler terms, namely: "How does one define value as it pertains to NCAA sport teams?"

While tied to the NCAA sporting world, United States Military Academy (USMA) and its sister service academies are unique, as they are not constrained by some of these intricacies. The military nature of the schools establishes a fundamentally different culture and end-state for its students. At USMA, each cadet will graduate with a Bachelor of Science degree and a 5-year obligation to serve the nation as a second lieutenant in the United States Army. This drives admissions and daily functions at the Academy. These differences have brought forth the question of how this unique value is defined. This is the driving function of this research. This research seeks to define value as it pertains to NCAA sport teams at USMA. The proposed solution to this research is to establish a value model, which encapsulates the complexities of USMA, that assesses NCAA sports in a numerical manner. Stakeholders will utilize the results of the data to address strengths and weaknesses of sports teams to better mold cadet-athletes into leaders of character.

1.2 Literature Review

1.2.1 United States Military Academy

USMA is a Department of Defense funded school with a mission "to educate, train, and inspire the Corps of Cadets so that each graduate is a commissioned leader of character committed to the values of Duty, Honor, Country and prepared for a career of professional excellence and service to the Nation as an officer in the United States Army" (Office of the Superintendent, 2018). This mission is brought forth in day-to-day life as the school pushes each cadet through a 47-month journey known as the West Point Leadership Development System (WPLDS) that entails a series of rigors and academic

hardships that challenge each cadet in different ways. USMA pushes its cadets to be more than the base NCAA standard of a scholar-athlete; the school harbors an environment to create leaders of characters that are tough and resilient in all facets of life. This culture trickles into how the Academy formally assesses its cadets, as performance is evaluated across four distinct pillars: military, academic, character, and physical. These are the base roots of what is valued in establishing the mission of West Point and will be leveraged as key factors in value modeling.

1.2.2 Value Modeling

Value modeling is the modeling of real-world applications in a manner that helps illustrate what value, or lack thereof, is attributed to each alternative. This systems-like approach helps clients and decision-makers analyze projects and variables against one another to assess different options. The model itself can be as simple or complex as the situation requires, but it must reflect the problem and validate the utilized metrics (Parnell, 2009). Equation 1 below shows the function for an additive value model.

$$v(x) = \sum_{i=1}^{n} w_i v_i(x_i) \quad (1)$$

This base function is taking raw inputs, *x,* and assigning values, *v(x)*, to each.. These values are then multiplied by respective weights, *v*, assigned to each metric. The summation of all values outputs the cumulative value of the situation. The attained value from these models, *v(x*), can be illustrated in numerous manners to aid in the analysis or the situation (Parnell, 2009). These results can range from a numerical output to histograms, tornado diagrams, or cumulative distributive functions.

Weights are an integral piece of value modeling as they help quantify how each metric in the model is assessed relative to the other metrics. Of the most basic approaches to weighting the value measures in a value model, one is likely to use and validate the model given importance weights. Importance weights, a subjective-based model, are assigned metrics that are measured via feeling. For example, the question that tends to be utilized is how does one rank objective 'x' to objective 'y' (Parnell, 2009). While feasible, this method lacks depth. Other weighting methodologies include matching, propensity weighting, rank weighting, swing weighting, or a combination thereof (Mercer, 2018).

1.2.3 Rank Weighting

Rank weighting is type of value measure weighting that ranks the weights of metrics in descending rank from 1 to *n*. Rank weighting is an approach to multi-criteria value modeling as it a deterministic approach that enables a simplistic approach to weight assignment. As the number of criteria increases, the complexity of the value model increases as more comparisons are necessary to establish the importance of the criteria with respect to the model. The rank weighting process decreases this complexity by assigning a value based on its rank with respect to the total number of criteria in the value model (Alfares, 2004). The function below, Equation 1, shows how each weight is derived with respect to rank, *r,* and number of criteria, *n.*

$$w_{r,n} = 100 - (3.195114 + \frac{37.75756}{n})(r - 1), 1 \leq r \leq n,\ r \text{ and } n \text{ are integer} \quad (2)$$

2. Methodology

2.1 Systems Thinking: Systems Decision Process

Systems thinking represents a framework and understanding of how to approach situations and create tangible solutions to real world phenomena. The Systems Decision Process (SDP) is a methodology of how to walk through the systems thinking process through a four-step iterative loop that establishes requirements along its flow. The four processes that make this flow are outlined as Problem Definition, Solution Design, Decision Making, and Solution Implementation. The completion of each step in the model establishes an output that is necessary as an input for the next step in the SDP (Trainor, 2010). This iterative process eases the understanding of the situation and what information is necessary, considering the scope of the problem, feasibility of solutions, and what products could aid in the solution of the situation.

2.2 The Project

The goal of the research is to build a model that helps quantify the value of each NCAA sports team at USMA through a holistic lens that encapsulates the unique nature of the school. This model will establish a metric by which decision makers can objectively evaluate teams and identify strengths and weaknesses by which to aid the school's sporting programs. Through

an internal view on the culture of the school, primary values were identified as integral to the formulation of the model and its validity. These values aided in the understanding of current perceptions and what additional factors should be considered in the conception of the value model.

Analyzing these values was an integral step in beginning model formulation. These values were assessed and were further broken down into a series of hierarchies based on association. In a series of stakeholder engagements, these values were validated and ranked against one another to help establish a weighting of metrics. This improved overall understanding of how value was defined and definitions for how to assess value measures within the value model. Simulated data was used in the model to achieve tangible results. Excel was utilized in the creation of this model for ease of usability and analysis due to the prevalence of the software.

2.3 Stakeholder Analysis

Stakeholders had a profound effect on the formulation of the value model. Aiding the understanding of value attributed to NCAA sports teams at USMA, ten distinct stakeholders were identified due to their unique lens and connection, or lack thereof, to the situation. The stakeholders that were engaged varied in positions including coaches, officer representatives (ORs), academic department heads, players, school officials, and admissions. Each engagement began with the question of how the stakeholder defines value as it pertains to NCAA sport teams at USMA. While varying in scope and intent, Figure 1 shows a functional hierarchy of key findings that were extrapolated from these discussions. This functional hierarchy shows how value is defined in terms of metrics and measures of said metrics.

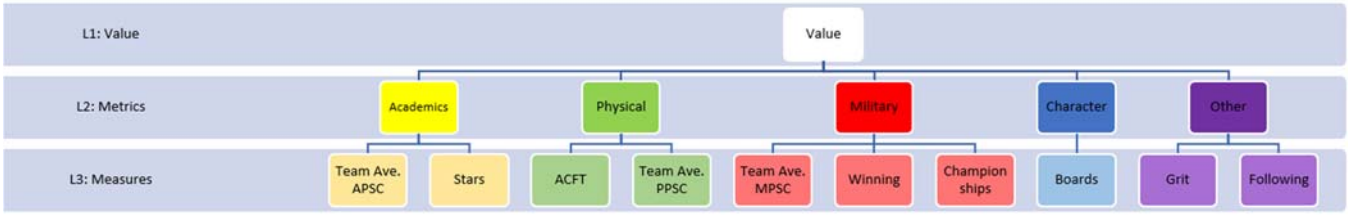

Figure 1. Stakeholder Analysis of Value at USMA NCAA Sports Teams

The insights of the stakeholders suggested that the four pillars, academic, military, physical, and character, were intrinsic to value at the school as they are the driving functions of a cadet's performance score (CPS). From these four pillars, the sub-metrics (lighter colors) were key measurable functions of USMA that aid in defining value related to their parent metric. A fifth metric was established to encompass key findings that did not hold to one of the others. Skills that are not easily measurable, such as grit, warrior ethos, and time-management skills, were also prevalent in these discussions. While most are incorporated into the model above, others were dismissed due to the abstract nature of the skill. Table 1 shows how this value (L1) is a function of five metrics (L2) comprised of 10 separate measures (L3). This hierarchy is the foundation by which the model was established.

The academic metric is comprised of two value measures: Stars and Team Average Academic Program Score Cumulative (APSC). Stars signify that a cadet has maintained two consecutive semesters with a 3.66 or higher GPA. The star value measure is a ratio of players who have stars to those who do not at the moment the data is taken. This metric is utilized as it promotes an additive factor of excelling academic cadets on each team. The APSC factor is the mean of the team's APSC. The APSC provides foundational understanding of how cadets are performing in the academic spectrum. It is integral to understanding value as it pertains to the academic pillar and how value is attained through academics.

The physical metric is comprised of two value measures: the Army Combat Fitness Test (ACFT) and the Physical Program Score Cumulative (PPSC). The PPSC factor is the mean of the team's PPSC. The PPSC is analogous with the APSC as it relates to physical measures at USMA. The ACFT is a fitness test that is administered each semester to test the overall fitness of the cadet. The value measure will take the NCAA team's average score of the most recent semester. This measure is utilized as the ACFT is not currently captured in the APSC and is a good measure of the physical fitness of cadets at USMA.

The military metric is comprised of three value measures: the Military Program Score Cumulative (MPSC), Winning, and Championships. The MPSC is analogous with the APSC and PPSC as it captures the military functions of cadets at USMA. The winning value measure is a four-year ratio of a NCAA team's win-to-loss ratio. This time frame was chosen as it will encapsulate the four years that the most recent senior class would have been with the team. The championship measure is the number of championships a team has won over the past four years, utilizing the same four-year window as winning for continuity. These championships encompass all major titles, such as league and national championships or regular season

champions. Championships and winning were utilized under the military metric rather than the physical metric as they pertain to the warrior ethos and competitive nature of the military. The physical metric is how the team performs on standardized testing separate from their NCAA team.

The character metric is comprised of a single function of boards. Boards are a repercussion at USMA of one's failure to act in accordance with the standards of policy and regulations as it pertains to the school. This measure is a holistic summation of disciplinary boards, honor boards, number of cadets sent through the Army Mentorship Program (AMP) over the past four years, and the number cadets on the team that have been separated from the school over the past four years. It is acknowledged that the four sub-categories all denote a negative connotation of character and fail to recognize the positive aspects of this trait. Positive aspects of character are difficult to analyze appropriately, and therefore will be represented through the absence of these board numbers.

The final metric "Other" is comprised of two value measures: grit and following. Grit is a measure of the percentage of cadets that pass the Indoor Obstacle Course Test their Junior and Senior years with an A- or better grade. This measure was added due to an inherent aspect stakeholders valued that NCAA build this skill or trait of grit. While this could be represented under the military metric to account for the warrior ethos, it was excluded due to its standardized testing at USMA. This measure has a paralleled measure of that of Stars in the academic metric as it promotes an additive factor in excellence. The following measure is a comparison of how the team's current following is in relation to other NCAA teams in the country. This is to be used to highlight if any team is more prevalent than others at the Academy. This metric will use ratios from social media accounts, such as the University of Indiana, to facilitate this scoring to see if the team at the academy has a relatively high, medium, or low comparison. Following was added under this other metric as is not accurately represented under any other metric in the functional hierarchy. The value added from this measure is the favorability of the team in relation to public perception.

2.4 Process Methodology and Value Model

The value model was constructed as an Excel-based tool to aid in project usability. The model is straight forward as the only requirement for the user is to input raw data with respect to each metric for the final value to compute. There is a manipulation aspect to the model as the user can choose what ranks to assign to each metric, or if the metric should be included in their analysis.

The initial stage of the model requires the user to input 14 distinct pieces of raw data into the model for each team. As shown below in Table 1, each row is dedicated to a specific team and the inputs associated to their team. The table displays data for three fictious teams and their corresponding fictious data. On the top line of the table are metric IDs with a letter-number combination; each of these unique letter-number IDs corresponds to a metric. Table 1 only requires the user to input the raw data of the metric. Some of these inputs include team size, ACFT average, and win/loss record of the team over the past four years.

Table 1. Raw Data Input Table for NCAA Teams

Team	Team Size (#)	A.1	A.2	P.1	P.2	C.1	C.2	C.3	C.4	M.1	M.2	M.3	O.1	O.2
Team 1	35	3.879272	8	552	2.278343	10	10	28	9	0.316529	3	4.499647	8	Low
Team 2	25	3.759409	7	487	1.990307	15	5	7	3	0.642788	5	3.928274	4	High
Team 3	28	3.636961	14	476	1.833194	13	20	7	6	0.13868	3	3.861137	7	Low

As shown in Figure 2, each measure has data that outlines what the measure is, how the metric is defined with respect to user input, and what value is associated to each input. To help aid in visibility, all measures are color-coded in their parent metric color. For example, the team average ACFT and team average PPSC are both green like their parent metric, Physical. The graphics to the right of the value function charts illustrate the trend and annotates whether the metric has a more-is-better (MiB) or less-is-better (LiB) association. As shown below in Figure 2, the team average ACFT increases linearly in value as the team average increases.

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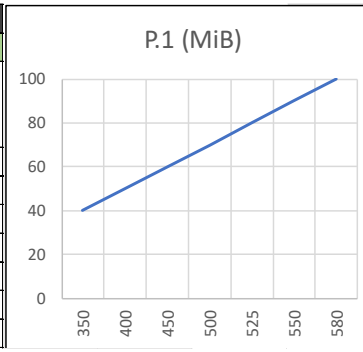
ID	Physical
P.1	ACFT
Team Average of ACFT	
350	40
400	50
450	60
500	70
525	80
550	90
580	100



P.2	PPSC
Team PPSC Average; Incorperates DPE, Sport, IOCT	
<= 1.67	12.50
2.00	25.00
2.33	37.50
2.67	50.00
3.00	62.50
3.33	75.00
3.67	87.50
>= 4	100.00

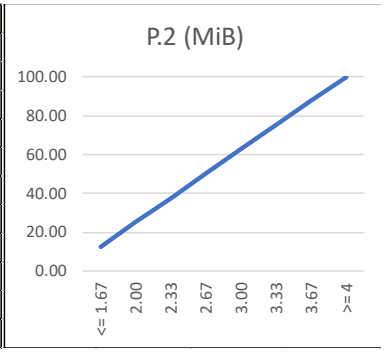


Figure 2. Value Measures for Physical Metric of Model

When all raw data has been consolidated, the user can utilize the pre-existing ranks that have been identified for each of the five value measures or change based on their preference. This feature is shown below on the left side of Figure 3. The five metrics, academic (A), physical (P), character (C), military (M), and other (O), are annotated by their first letter and color for ease usability. Below, '1' is the metric of the greatest importance while '5' represents the metric that has the least importance, from the opinion of the user. These five value measures will be assigned their respective rank weight, derived from the use of Equation 2, and populate the value attributed to each of their value measures. The five value measures will then be summed to quantify the value of each team. When evaluating this value, as shown in Figure 3, the value will be represented out of a maximum of 100 for ease of comparison. These values are conditionally formatted to where higher numbers appear more green and lower numbers appear red to aid in analysis.

Ranking				
A	P	C	M	0
2.00	1.00	4.00	3.00	5.00

A	P	C	M	0	Value	Team	Rank
16.16	17.64	9.95	13.54	10.89	68.18	Team 1	2
6.74	16.57	17.37	10.81	14.52	66.01	Team 2	3
11.69	24.68	12.42	12.11	10.89	71.79	Team 3	1

Figure 3. Weight Ranks with Cumulative and Metric Value Score

Figure 4 gives a visual representation of several fake teams in a stacked bar chart. This chart has been populated with data from random number generators to aid in the testing of the model. This aid is helpful in the analysis of teams against one another and identifying strengths and weaknesses of each respective team. As shown below, team 2 is low as their academic value, yellow bar, is comparatively smaller to the rest of the teams. This is easily identifiable upon visual inspection on the bar-chart to the left of Figure 4. Again, the colors align with the metrics, such as yellow representing the academic metric, throughout the model for ease of comparison.

To further aid in analysis, the excel model enables users to isolate certain teams and certain metrics; if the user desires to inspect team 1, team 2, and team 3 with respect to the academic metric, the graph will populate this for a clearer inspection. The chart on the right of Figure 4 illustrates this isolated metric feature. This feature is helpful as it allows for a clean 1-v-1, or 1-v-*n,* inspection of teams with one or multiple metrics. For the user, the utility of this feature will greatly aid in ascertaining strengths and weaknesses of teams in relation to one another. For example, if team 1 is struggling while team 2 is excelling in the same area, the user may utilize this information to create a plan to have team 2 assist with bolstering the deficiency of team 1. This also provides insights as to what is creating value versus what is not. Replication of these behaviors and mannerisms to others will increase the potential for added value amongst teams.

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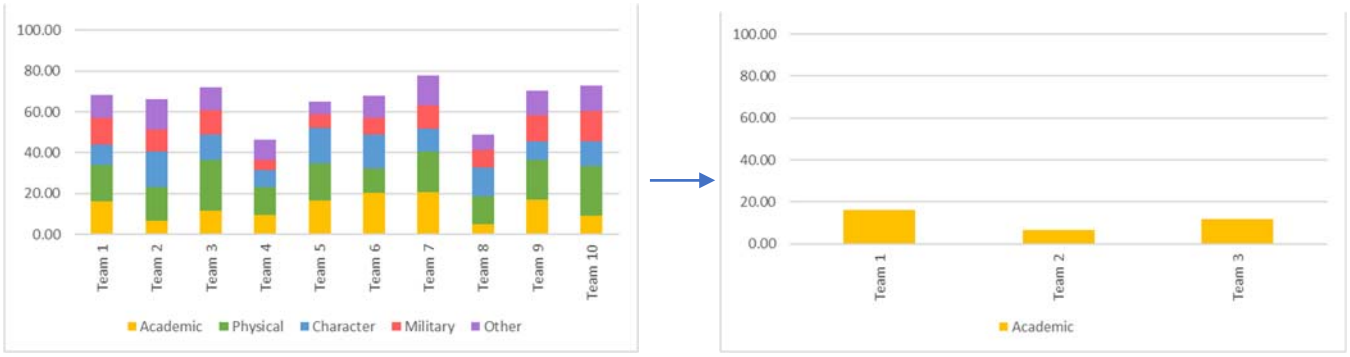

Figure 4. Stacked Bar Charts of Teams

2.5 Sensitivity

A methodology to compare sensitivity of the value model is through the use of a tornado diagram. It is important to analyze sensitivity of models as they give insight to the question "What makes a difference in this decision?" (Clemen, 2013). Tornado diagrams allow for an analysis of the output given variability weights in relation to the inputs. In Figure 5 below, the tornado diagram shows sensitivity for three value measures, Team MPSC (M.3), Team Average APSC (A.1), and Character function (C). These three were chosen as they all account for different portions of their respective metric. Because they are normalized equally in with other measures in their metric, they account for different portions of their parent metric. The M.3 measure accounts for 1/3 of the military metric, the A.1 measure accounts for 1/2 of the academic metric, and the C measure accounts for the entirety of the character metric. These three represent measures of the same optional value of their metrics. For example. The A.1 measure will have the same sensitivity as the P.1 measure for the physical metric. These three measures were varied from a base case of 50, the average value score, by 25% in each direction. On the left legend, the 1st, 3rd, and 5th addition to each measure indicates what rank weight the measure was given when the analysis was conducted. For example, A.1: 3rd represents the Team Average APSC measure when the academic metric was valued to be the third most important metric.

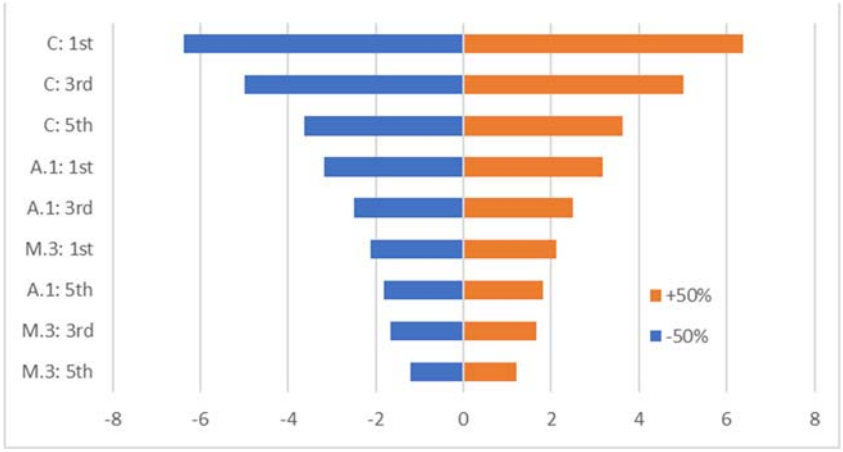

Figure 5. Tornado Diagram of Three Measures with Differing Priorities

A key insight from Figure 5 is that as there are more measures that make up the parent function, each measure is less sensitive to changes in their input. This means that the measures for the military metric are less sensitive, regardless of a top priority ranking, because each measure accounts for a third of the metric. The measures found in the academic, physical, and other metrics are all comparable as they follow the sensitivity of A.1 in Figure 5 above. The most significant measure and metric of the model is the character metric as it is comprised of a single function. This causes the C measure to have the largest variation and is most sensitive to changes in inputs.

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Another note on this model is that as the metric is valued more, such as being the 1st priority over a 3rd priority, the sensitivity of each measure increases. This is representative throughout the tornado diagram as each measure decreases in sensitivity as their priority decreases. These remain relatively group together. One point of emphasis is that if the military metric is weighted the top priority, it will have more sensitivity than if the academic, physical, or other metric if they were labeled as the 5th priority. The character metric dominates in overall sensitivity.

2.6 Model Validation

Validation of the model will be completed by two different methods. The first way the model will be validated will be through stakeholder and user perception. Upon inputting raw data into the model, stakeholders will be first asked to rank the five metrics of the model from 1-5 as they perceive their value. Once complete, these will be inputted into the model to finalize values for each metric and populate each NCAA sports team's final value score. Prior to seeing these results, each stakeholder or user will then be asked to rank the 28 different teams in the same manner as the metrics. The team ranking each stakeholder creates will then be tested against the model. These preconceived notions will aid in the validity of the model as the stakeholder will have to access the deterministic value that the model produces. If the model follows logic within the stakeholder's analysis and ranking of metrics, this aids in model validity.

The other means to aid in system validation is through a survey with the system usability scale (SUS) to assist in model usability and effectiveness. The SUS is a ten-question assessment of a system by which the user can return feedback on the overall utility and provide recommendations if there are points of friction in the tool. The feedback will be manipulated to create further refinements in the scope of the model and the overall workability of the interface. This validation system will aid in future use and usability of the value model.

3. Findings

The current model is tested and trained on simulated data established by random number generators (RNGs). Through these, the model was found to produce results that enabled the user to input data, manipulate weights, and derive a base understanding what value is associated to the teams. This simplistic approach enabled the user to numerically and visually inspect teams against one another to find where value is gained and lost with teams.

These numbers have no standing on the results of the research and no concrete conclusions can be deduced that can be utilized and applied to the NCAA sports teams of USMA. Findings are to be published at a later time when data has been gathered and filtered through the model. The conclusions and findings from this real, raw data will enable the user to better understand the situation of NCAA sports teams at USMA for that point in time. With these conclusions, the user can have the information to address weaknesses or strengths of teams to better create leaders of character.

4. Conclusions and Future Work

In conclusion, the premise of this model is to define value as it pertains to NCAA sports teams at USMA through its unique nature. After a holistic look at the school and its culture, five distinct metrics were identified based off traditional stances of value and stakeholder inputs. Through a rank weighted model, the inputs were transformed by their respective value measures and weights to quantify value as it pertains to each respective NCAA sports team; their strengths and weaknesses were apparent and were accurately displayed through the value output of the model. This value model was validated by the simulated data and established a sound representation of how raw data will be transferred into value. This model allows for the user to manipulate weights to assist in a broader decision analysis. Users of this model may include the athletic and academic heads to identify trends of strengths and weaknesses of cadets on these sport teams. Courses of action can then be constructed of how to adjust the current trends to create value, and therefore, better leaders of character at USMA.

As the model only provides a single snapshot of teams, this model will need to take data from different periods of time to account for larger moving trends. For a basis, the recommended data should review the previous five-years of each sports team at USMA, taking data at the end of the fall and spring terms. This data set would establish a contemporary picture of each team and the trends associated with each. The insights that can be derived from this five-year period may provide users and decision makers more standing to make decisions to adjust behaviors of teams to create better leaders of character at USMA.

For future work, it is recommended that the overall scope and robustness of the value model be increased. Some additional metrics that were identified by stakeholders were retention in the Army, time management, teamwork, and people skills. These additional metrics increase the scope and lens of how value is defined at USMA. These metrics need to be considered in a larger, robust model to full account for these skills. The current metrics and measures will to be re-evaluated

as some may appear to be biased or have correlations. For example, the grit measure will likely provide better results for a gymnast rather than offensive lineman. A future approach to this grit measure may be to measure of change between the initial IOCT score and final IOCT score. The change would highlight those who put forward extra time and effort and would represent the grit behavior more comprehensively.

Another recommendation is that this model be utilized at other military academies, such as USNA and USAFA, for future work. While United States Naval and Air Forces Academies have their respective cultures, the military aspect of these institutions allows the model to be translated to the other service academies if they so choose to use to apply this model. Adjustments will need to be administered to account for the uniqueness of the other two academies. However, the base value model will remain fairly consistent as there are many parallels in academy operations.

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